Abstract

Experimental Design – Comparative Study

Assessing the influence of fabric finishing treatments, involves a number of complex questions, and the priority of these questions is different for different disorders and for different stakeholders. Therefore, it is essential that we do not adopt a one-method-fits-all approache.

The present paper illustrates the attributes of the DOE and L9 designs by analyzing data from trials adopting these designs. Our case study suggests that the L9 design can provide definitive answers to important questions and may be a useful design for assessing fabric finishing processes effects.

Three famous methods of experimental design ,i.e. full factorial design DOE, L9 orthogonal array of the Taguchi method, and the randomized block design RBD, were implemented to investigate the effects of experimental conditions to prepare non polymerized gas plasma (Ar) treatment on micro-fiber polyester fabric tailor ability properties .The results showed that the favorable phase tailor ability was improved by increasing the exposure time (X1)and energy (X2), whereas increasing both X1 and X2, decreased fabric resistance to sewing penetration , i.e. improving fabric sewability. No significant changes in fabric weight of the final products were observed by increasing the variables X1 and X2. In addition, Ar, effects ,which was used in the low and mid variable levels runs, was not be highly affected as it at high variables levels due to its low polymerized stability.

Keywords:

Micro-fiber polyester fabric –No polymerized gas plasma – Modified fabric sewabillity tester (ST2) - Experimental design (factorial design," DOE" – Taguchi design,"L9")- Randomized block design (RBD)-Fabric skin comfort.

الملخص

تصميم التجارب ـ دراسة مقارنة

لتقدير مدى تأثير تجهيزات الاقمشة توجد عدة تساؤلات وأولويات هذة الاسئلة تتمثل فى رغبات العميل ، لذلك فانه من الاساسى ان يكون هناك مدخلا لتصميم التجارب فى البحوث العلمية ويوضح هذا البحث نظام تصميم التجارب وتحليلها المعروف بنظام تاكوشى ودراستنا توضح ان هذا النظام قادر على الاجابة على الاسئلة الهامة كما يعد وشيلة مناسبة للحكم على عمليات تجهيز المنسوجات .

يتناول هذا البحث ثلاث طرق مشهورة لتصميم التجارب هى التصميم الكامل للتجارب ، تصميم تاكوشى ، والتصميم العشوائى .

ويهدف الى تحديد الظروف المثالية لتشغيل الأقمشة الفائقة النعومة (الميكروفير) من شعيرات البولى استر عند تفصيلها بعد معالجتها بالبلازما .

وأوضحت نتائج الدراسة أنه بزيادة زمن التعرض للغاز والطاقة الكهربية المستخدمة تقل مقاومة الاقمشة للاختراق وتتحسن قابليتها للحياكات ،ثبت أيضا أنه لا توجد فروق معنوية فى وزن القماش المعالج .كما ثبت ايضا أن التأثيرات الناتجة عند استخدام غاز الارجون عند المستويات الاقل والاوسط من الطاقة ليست لها تأثيرات معنوية واضحة .

الكلمات المفتاحية :

الأقمشة الفائقة النعومة (الميكروفير) – المرسرة بغاز البلازما – قابلية الاقمشة للحياكات تصميم التجارب ـ التصميم الكامل للتجارب ـ تصميم تاكوشى ـ والتصميم العشوائى .

Conclusion:

paper will be an excellent resource for both research and industrial fraternities who are involved in DOE projects.

Generally speaking, Taguchi and random designs often perform better than factorial designs depending on size and assumptions. When choosing the design for an experiment, it is important to determine an efficient design that helps optimize the process and determines factors that influence variability . In various technological fields, it is important to design experiments where a limited number of experiments is required.

Acknowledgments:

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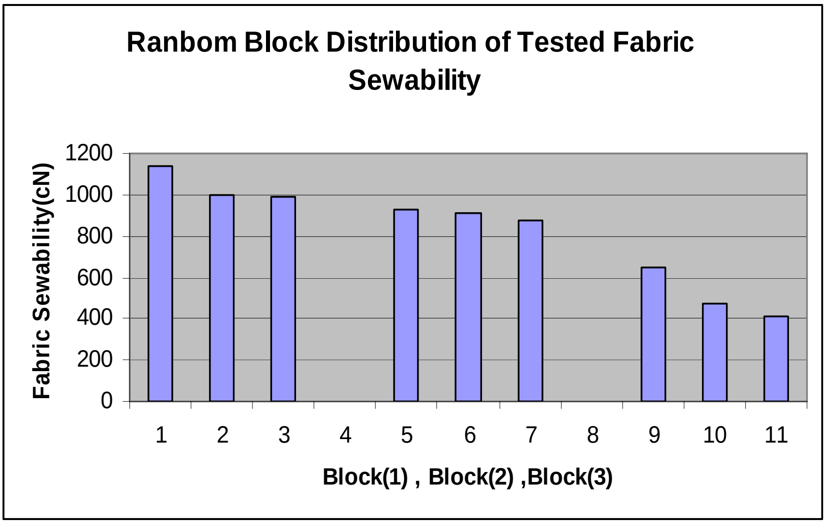

Fig.6. Results of the Randomized Block Design

It is clear from Table 7 ,that ,block "3" gives the highest effect of fabric sew ability , while block "1" gives the lowest influence ,and block "2"stands at mide position between them. Random experiment is an experiment whose result would not be predicted but the list of possible outcomes are known. The unpredicted outcomes could not be taken under random experiments. The result of random experiments may not be predicted exactly but the result must be with in the list of predicted outputs.

It is clear that block (3) referees to the best fabric dry finishing treatment , from fabric sew ability point of view. Design/methodology/approach – The first part of the paper shows the differences between classical DOE and Taguchi methods from a practitioner's perspective. The second part of the paper illustrates a simple framework which provides guidance in the selection of a suitable DOE strategy. The last part is focused on a simple case study demonstrating the power of Taguchi methods of experimental design.

Findings

One of the key questions from many quality and production related personnel in organisations are “when to use Taguchi and Classical DOE?”. The purpose of this paper is to make an attempt to address the above question from a practitioner's perspective.

The case study is based on Taguchi method of experimental design. It would be great to see the results of the study if classical DOE is performed to this study.

variables that contribute significantly. Random design does not work very well with relatively smaller systems.
In various technological fields, it is important to design experiments where a limited number of experiments is required. Random design is practical for many design applications. Extensive mathematical theory has been used to explore random experimental design. Examples of random design include areas of data compression and medical imaging.

3.4.1.Randomized Block Design (RBD)

3.4.1.1Description of Design

Randomized block design (RBD) takes advantage of grouping similar experimental units into blocks or replicates. One requirement of RBD is that the blocks of experimental units be as uniform as possible. The reason for grouping experimental units is so that the observed differences between treatments will be largely due to “true” differences between treatments and not random occurrences or chance.

3.4.1.1.1.Procedure for Randomization

1) Randomize each replicate separately.
2) Verify that each treatment has the same probability of being assigned to a given experimental unit within a replicate.
3) Have each treatment appear at least once per replicate.

3.4.2.The Randomized block design:

Table ٧ ,shows the results of randomized block design of tested fabrics.

Blocks/ Parameters	**1(Low treatment -1)**	**2(Average treatment, 0)**	**3(High treatment ,+1)**
µ/ б /CV%/S/N/t α	1039.4/82.9/7.9%/21.965/2.66	905.4/27.1/2.9%/30.477/5.503	509.2/121.7/23.9%/12.432/6.236

Table 6 (B)

Trials	1	2	3	Aver.	SN
1	2.6	2.8	2.4	2.6	7.6
2	3.2	3.1	3.4	3.2	5.1
3	2.2	2.7	2.5	2.5	7.9
4	2.4	2.3	2.1	2.3	8.6
5	2.4	2.8	2.6	2.6	7.6
6	2.5	2.7	2.2	2.5	7.9
7	2.8	2.9	2.8	2.8	6.9
8	2.7	2.5	2.9	2.7	7.2
9	2.7	2.5	2.4	2.5	7.9
10	3.1	3.2	3.4	3.2	5.1
11	3.5	3.7	3.1	3.4	2.9
12	3.8	3.7	3.2	3.6	2.9
13	2.8	2.9	2.9	2.9	6.4
14	3.1	3.4	3.2	3.2	5.1
15	3.5	3.7	3.4	3.4	4.1
16	3.3	3.1	3.6	3.2	5.1
17	3.6	3.5	3.2	3.4	4.1
18	2.9	2.9	2.9	2.9	6.4

It was found that:
SNp-1 = 7.411 , SNp-2 =6.616 , SNp-3= 6.183 , It is clear that expusure time has the largest effect on seam puckering ,while gas tpye has the lower effect.
SNp-4 = 5.416 , SNp-5 = 5.5 , SN p-6 = 5.75 , and SNp-7 = 6.033.
On the other hand ,needle size plays a major part in seam puckering ,and fabric size comes in last position.

3.4. Design of experiments via random design

Random design is an approach to designing experiments. As the name implies, random experimental design involves randomly assigning experimental conditions. This type of experimental design is surprisingly powerful and often results in a high probability to create a near optimal design.
The simplified steps for random design include the following:
1. Choose a number of experiments to run
2. Assign to each variable a state based on a uniform sample. For instance, if there are 5 states, each state has a probability of 20%.

Random designs typically work well for large systems with many variables, 50 or more. There should be few interactions between variables and very few

Table 5. show The experiment using Taguchi method

Experiment Number	P1	P2	P3	P4	P5	P6	P7	P8
1	1	1	1	1	1	1	1	1
2	1	1	2	2	2	2	2	2
3	1	1	3	3	3	3	3	3
4	1	2	1	1	2	2	3	3
5	1	2	2	2	3	3	1	1
6	1	2	3	3	1	1	2	2
7	1	3	1	2	1	3	2	3
8	1	3	2	3	2	1	3	1
9	1	3	3	1	3	2	1	2
10	2	1	1	3	3	2	2	1
11	2	1	2	1	1	3	3	2
12	2	1	3	2	2	1	1	3
13	2	2	1	2	3	1	3	2
14	2	2	2	3	1	2	1	3
15	2	2	3	1	2	3	2	1
16	2	3	1	3	2	3	1	2
17	2	3	2	1	3	1	2	3
18	2	3	3	2	1	2	3	1

When we replace P1, P2, P3, and P4 with our parameters and begin filling in the parameter values, we find that the L9 array includes 3 levels for gas type, while our system only has 2. The appropriate strategy is to fill in the entries for P4=3 with 1 or 2 in a random, balanced way.

Table 6 (A&B) show the parameters and levels effecting Denim fabric seam puckering.

Table 6 (A)

Parameters	1	2	3
P1(min)	2	4	6
P2(kV)	1	1.5	2
P3(-)	Ar	He	He
P4 (ktex)	A	B	C
P5(Ne)	20/2	40/2	60/2
P6(spc)	3	6	9
P7(Nm)	70	90	110

$$SN_{P3,1} = \frac{(S_{N1} + S_{N6} + S_{N8})}{3} \qquad (22)$$

$$SN_{P3,2} = \frac{(S_{N2} + S_{N4} + S_{N9})}{3} \qquad (23)$$

$$SN_{P3,3} = \frac{(S_{N3} + S_{N5} + S_{N7})}{3} \qquad (24)$$

3.3.1. L 4, Taguchi experimental design:

A Taguchi L 4 (2^3)is chosen, where, number ,4, indicates the number of experiments , (2) represents the number of the studied parameters, and (3) indicates the number of experimental levels. The experiment using Taguchi method was considered ,as shown in Table 4.

3.3.2..Case study:

Let , parameter: A (expusure time – min.), B(energy –kV) ,C(gas type) ,D (fabric size- ktex) , E (thread size - Ne),F (seam size-spc), G (Needle size -Nm) = 7

where levels: 3, 3, 2, 3, 3, 3, and 3 = ~3

array: L18

There are 7 parameters, and each one has 3 levels with the exception of gas type. The highest number of levels is 3, so we will use a value of 3 when choosing our orthogonal array.

Using the array selector above, we find that the appropriate orthogonal array is L18:

$$SN_i = -10\log\left(\sum_{u=1}^{N_i}\frac{y_u^2}{N_i}\right) \quad \textbf{(20)}$$

For the case of maximizing the performance characteristic, the following definition of the SN ratio should be calculated:

$$SN_i = -10\log\left[\frac{1}{N_i}\sum_{u=1}^{N_i}\frac{1}{y_u^2}\right] \quad \textbf{(21)}$$

After calculating the SN ratio for each experiment, the average SN value is calculated for each factor and level. This is done as shown below for Parameter 3 (P3) in the array:

Table ٤ , shows the average SN value is calculated for each factor and level

Experiment Number	P1	P2	P3	P4	SN
1	1	1	1	1	**SN1**
2	1	2	2	2	**SN2**
3	1	3	3	3	**SN3**
4	2	1	2	3	**SN4**
5	2	2	3	1	**SN5**
6	2	3	1	2	**SN6**
7	3	1	3	2	**SN7**
8	3	2	1	3	**SN8**
9	3	3	2	1	**SN9**

Where :
(Constant), X11, X1X2, X2= Energy(kV) , X1= Exposure time (min)
Dependent Variable: Fabric sew ability (cN)

3.3.Other Methods of Experimental Design

The Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varies. Instead of having to test all possible combinations like the factorial design, the Taguchi method tests pairs of combinations. This allows for the collection of the necessary data to determine which factors most affect product quality with a minimum amount of experimentation, thus saving time and resources.
To determine the effect each variable has on the output, the signal-to-noise ratio, or the SN number, needs to be calculated for each experiment conducted. The calculation of the SN for the first experiment in the array above is shown below for the case of a specific target value of the performance characteristic. In the equations below, yi is the mean value and si is the variance. yi is the value of the performance characteristic for a given experiment.

$$SN_i = 10 \log \frac{\bar{y_i}^2}{s_i^2} \qquad (19)$$

$$Where:$$

$$\bar{y}_i = \frac{1}{N_i} \sum_{u=1}^{N_i} y_{i,u}$$

$$s_i^2 = \frac{1}{N_i - 1} \sum_{u=1}^{N_i} (y_{i,u} - \bar{y}_i)$$

$$i = Experiment\ number$$
$$u = Trial\ number$$
$$N_i = Number\ of\ trials\ for\ experiment\ i$$

For the case of minimizing the performance characteristic, the following definition of the SN ratio should be calculated:

Table 2. Variables and Experimental Levels of Central Composite Rota table Design.

Variables	-1	0	+1	Interval
X1=time min	2	4	6	2 min
X2=energy kv	1	1.5	2	0.5 kv

Table 3 , shows the influence of no polymerized gas plasma(Ar) on tested fabric sewabillity.

No	Z1	Z2	Z1Z2	Y(cN)
1	-1	-1	1	1135.03
2	-1	0	0	996.07
3	-1	1	-1	987.15
4	0	-1	0	927.01
5	0	0	0	914.15
6	0	1	0	874.94
7	1	-1	-1	646.03
8	1	0	0	468.64
9	1	1	1	413,03

Y=905.367 - 265.092 X1 - 72.158 X2 – 21.280X1X2 -131.042X11 (18)

3.2. Analysis of variance

There are two sources of variation among the n observations obtained from a CRD trial. One is the variation due to treatments, the other is experimental error. The relative size of the two is used to indicate whether the observed difference among treatments is real or is due to chance. The treatment difference is said to be real if treatment variation is sufficiently larger than experimental error.

ANOVA

Sig.	F	Mean Square	df	Sum of Squares		Model
.002	41.486	122259.423	4	489037.691	Regression	1
		2946.984	4	11787.934	Residual	
			8	500825.626	Total	

2-Fabric Compression Properties[5]:

Fabric Softness = FRNP max - FRNP min (11)

Fabric Compressibility Ration = FRNPmin / FRNPmax 100 (12)

Fabric Anzotropic = (FRNP max - FRNP min) / FRNPmax + FRNPmin) (13)

Where :

FRNP max & min are maximum and minimum fabric resistance to sewing needle penetration ,according to Fig.6.

3-Fabric wear ability Assessment :

Fabric wear ability index = 1 – (FRNP2/FRNP1). 100 (14)

4- Fabric Skin-Comfort[7-8] :

Specific Sewing Stress = Fabric Needle Penetration Force (cN) / Fabric weight (g/m2) x Sewing Needle size / 100 (mm) cN/tex (15)

Where:

SSS (min.) ………..means high comfort level (16)

SSS (max) …………means low comfort level. (17)

Results:

3.1. Design of Experiment for Two Variables:

A complete factorial design of two variables at three levels, namely, -1, 0, and, +1, were chosen to investigate the tested, 100% micro-fiber polyester fabric, after low temperature gas plasma treatment.

The results obtained were fed to "SPSS", and regression coefficients were determined. The coefficients were tested for significance at the 95% significance level. The time of treatment (X1) , and energy (X2), were selected as independent variables for the experimental design, since preliminary experiments had confirmed that these variables have the largest influence on the fabric wear ability properties.

The variables are kept within laboratory processing zone in order to obtain good flammability properties. The experimental domain and coding of the variables are shown in Table 2 , and the results of whole central composite design together with the observed (calculated) responses, is given in Table 3.

The complete central composite rot table design for two variables at three experimental levels requires neighed experiments and including five repeat experiments carried out to obtain an estimate for the within-treatment variation.

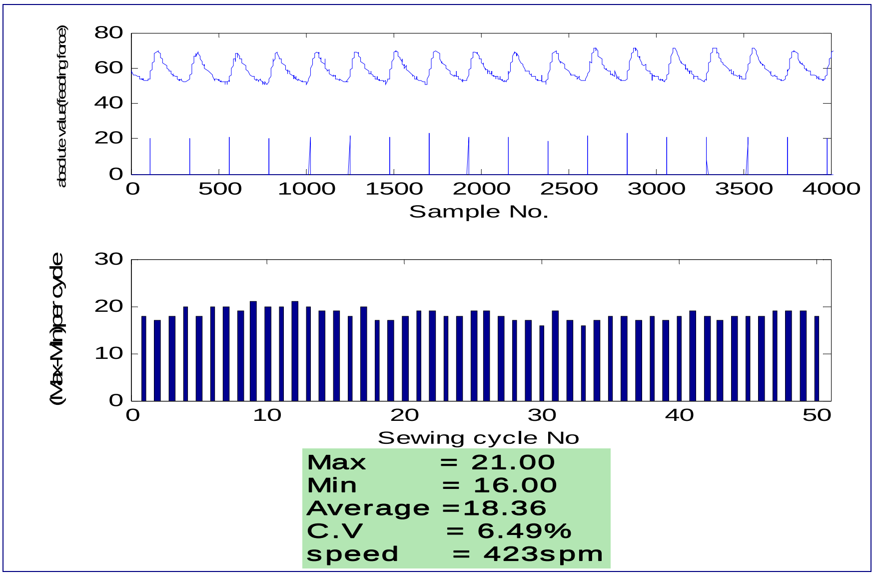

Fig. 5, Out put of, ST2.

2.4.3.Advantages of the instrument:

1. Only a small sample of the fabric is needed.
2. The test is rapid and the operating procedure is simple.
3. The versatility of the machine enables other investigations to be carried out.

The output of modified fabric sewabillity tester are mainly abstracts as follows:

1- Overall Fabric Tailorability Assessment [6]:

Fabric process ability, "FP", - Fabric Saw ability, "FSa" – Fabric Sew ability, "FSe" – and Fabric Formability, "FF".These Indexes may predictor as follows:

$FP = FRNP\ (min.) / W \times SS$, (5)

$FSa = FRNP\ (max) / W \times KS$, (6)

$FSe = FRNP\ (average) / W \times NS$, (7)

$FF = (FRNPmax - FRNP\ min) / BS$, (8)

Overall Fabric Tailor ability, "OFTI", is given by the following equation:

$OFT = \sqrt{}\ FP \times FSa \times FSe \times FF$ (9)

And the Critical Value of overall fabric tolerability is:

$0\ (Acceptance) \geq OFT \leq 1 (Rejected)$, (10)

Where:

W , SS , KS , NS , BS , OFT , are fabric weight (g/m2) , Spreading Size , Knife Size , Sewing Needle Size , Human Body Size , and OFT is the voice of costumer , respectively.

a) Fabric anisotropy (s); and

b) Fabric range (Δ);

In this work fabric wear ability, assessment has been calculated, as follows:

a- Measure fabric resistance to sewing needle penetration ,"FRNP1, and / or, specific sewing stress, SSS1: before dry finishing ,

b- Measure fabric resistance to sewing needle penetration after dry finishing, "FRNP2", and/or, specific sewing stress, SSS2, and

c- Fabric wear-tear index can be calculated as follows:

Fabric wear -tear index (FWI) = [1 – (SSS2/SSS1)]. 100 (%) (4)

If, SSS1 = SSS2 , it means no wear ,i.e., FWI = 0 % ,and if , SSS2 = 0, i.e. WFI – 100% ,it means full wear, therefore fabric wear ability ranges between , 0 % and 100%. When fabric wear ability index, reaches, 0%; it means no wear, i.e., excellent influence of gas plasma (GP), on fabric, and vice verse. The results of "ST2" (see Fig.4 and 5), tester are compared with the results of some of fabric properties, which are related to fabric wear such as: Fabric capillary rise, and Fabric weight loss, respectively. This test is used to measure the amount of wear a particular fabric

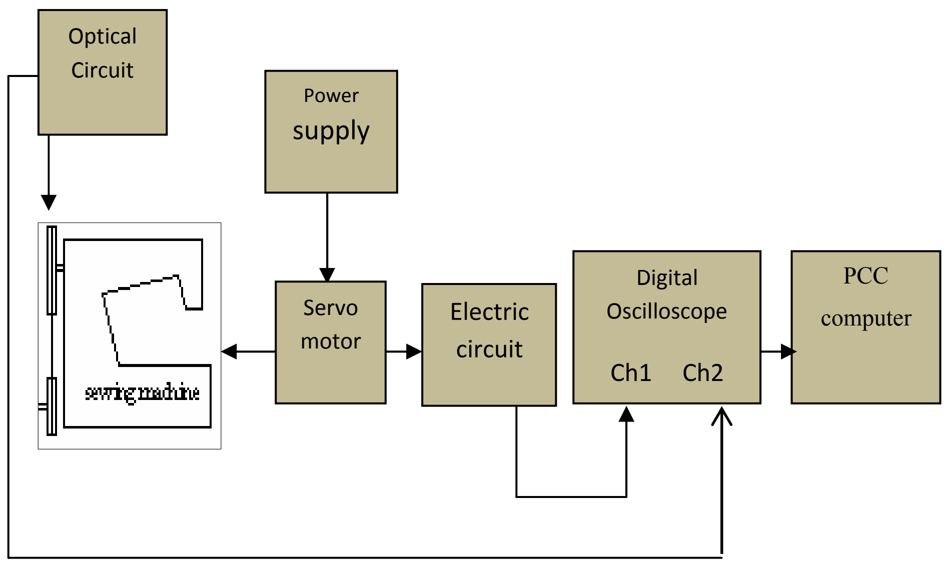

Fig.4. Modified Fabric Sewabillity Tester, ST2. [4-5].

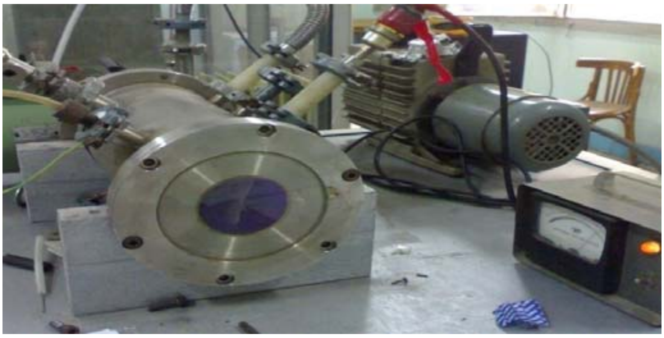

Fig. 2. Plasma apparatus .

2.4.New Approach to Fabric Tailor ability Assessment:

2.4.1.The development of new methods and instruments for the evaluation of apparel textiles(Voice of Process,VOP):

Fig .3 show the concept of macaronis in design and manufacturing of laboratory fabric sewabillity testes (ST2)

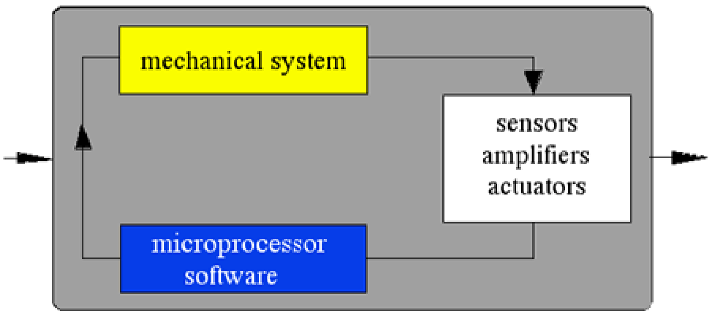

Fig3. shows the concept of mechatronics system.

2.4.2.Modified Fabric Sewability Tester , Voice of Process,"VOP:

The sewing needle penetration force, (FRNP), is the quantities measure of the damage which appears in agreement as the result of the sewing process. A high penetration force means a high resistance of fabric and thus a high risk of damage. Trials have been made to find out the magnitude of wear in a tested fabric using the modified fabric sewabillity tester (ST2).For this purpose different samples were subjected to low pressure gas plasma treatment for constant testing conditions.

Where:

$\overline{X}_i$ = single attribute median; Fi= cumulative frequency; and, Fi = absolute frequency, while overall attributes median is calculated using the formula:

$$\overline{X}_{is} = \sum_{i=1}^{i=11} \overline{x}_i / n \quad \text{-----------------} \rightarrow (2)$$

$$0 \leq X_{is} \leq 1 \quad \text{---------------} \rightarrow (3)$$

(Uncomforted) (Full comfort)

Higher values denoted more desirable quality.

2.2.Raw Materials :

100% polyester micro-fiber fabrics are generally lightweight, resilient or resist wrinkling, have a luxurious drape and body, retain shape, and resist pilling. Also, they are relatively strong and durable in relation to other fabrics of similar weight. Plasma treatment may be enhancing their wear ability property .Table1 shows the properties of tested fabrics.

Table 1, 100%, Polyester micro-fiber fabric properties [3].

Fabrics	Structure	Warp/Cm	Weft/Cm	Warp diameter μ	Weft diameter μ	Warp denier	Weft density
PES	Plain 1/1	44	35	20	16	4	2.5

2.3. Fabric Treatment:

The plasma process cylinder is 15 Cm diameter, and 35 Cm length. The system possesses two gas channels with a mass flow controller and magnetic valves for programmed, automatic precise gas flow in the process cylinder. The tested fabric samples were placed in the plasma cylinder as shown in Figs.4. The plasma cylinder was first pumped down to 0.187 tore (25 pas) then the gas was injected automatically by opening the gas valves. The gas flow rate was kept constant at, 60mL/min. [3].

states for each variable. The following will have the two experimental designs for the same scenario.

2.1. Fabric skin-comfort (Voice of customer –VOC):

Low emperature plasma , LTP" , is a useful technique to change the physical and chemical properties of textile fabrics. In this work the effect of "LTP" on physical and chemical properties of 100 % cotton fabric fabrics have been investigated, for different duration with variation of magnetic field. Plasma treatment causes mainly physical changes by creating mic-rocrck on fiber surface and increasing surface frictions. The concept of total fabric skin – comfort value is given in the following figure (Fig.1).

1- Optimum heat and moisture regulation, i.e.
2- Good air and water vapor permeability, i.e.,
3- Rapid moisture absorption and convey- acne capacity, i.e.,
4- Absence of dampness, i.e.,
5- Rapid draying to prevent catching cold, i.e.,
6- Low water absorption of the lager of cloth,
7- Dimensionally stability even when wet,
8- Durable , i.e.,
9- Easy of care, i.e.,
Light weight, i.e.,

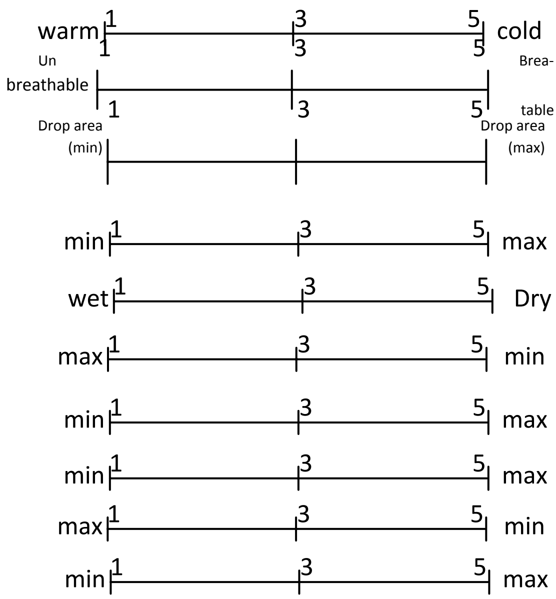

Fig .1: shows the concept of total fabric- skin comfort value [1 -2].

2.1. 1.Total fabric comfort.

The desirable attributes of fabric comfort is a function of the following items : optimum heat and moisture regulation , good air and water vapor permeability , dimensionally stable even when wet , durable , easy care , light weight , and pleasant touch . Total fabric comforts (TFC), has been calculated according to Hadidy test method (Fabric Tailor ability Assessment, Research (2007), [1]. Project, Mansoura University,

Total fabric comfort is given by the following equation:

$$\overline{X}_i = 4.5 - \frac{F_i - 0.5}{F_i} \quad \text{-------------} \rightarrow (1)$$

We are concerned with the analysis of data generated from an experiment. It is wise to take time and effort to organize the experiment properly to ensure that the right type of data, and enough of it, is available to answer the questions of interest as clearly and efficiently as possible. This process is called experimental design.

1.1.Types of Designs:

What are the different major types of research designs? We can classify designs into a simple threefold classification by asking some key questions.
True experimental designs include:
Pre-test/Post-test control group design
Solomon,s Four-Group design
Post-test only control group design
Pre-test/Post-test control group design.
To make things easier, the following will act as representations within particular designs:
X--Treatment
O--Observation or measurement
R--Random assignment

1.2.Purpose

The purpose of this investgation is to present some fundamental and critical differences between the two methods of experimental design (i.e. Taguchi and classical design of experiments (DOE)). It also aims to present an application of Taguchi method of experimental design for the development of fabric tailorability assessment in a cost effective and timely manner.

2.Materials and Test Methods:

Four-step process used in quality control and elsewhere as a simplified method of achieving improvements. These steps are: (1) Plan: determine what needs to be done, when, how, and by whom. (2) Do: carry out the plan, on a small-scale first. (3) Check: analyze the results of carrying out the plan. (4) Act: take appropriate steps to close the gap between planned and actual results. Named after its proposer, the US mathematician Walter Shewart (1891-1967). Also called Deming cycle, Deming wheel, or plan do check act (PDCA) cycle.
The first part of the paper shows the differences between classical DOE and Taguchi methods from a practitioner's perspective. The second part of the paper illustrates a simple framework which provides guidance in the selection of a suitable DOE strategy. The last part is focused on a simple case study demonstrating the power of Taguchi methods of experimental design. To obtain an even better understanding of these two different methods, it's good to get a visual of these two methods. It will illustrate the degree of efficiency for each experimental design depending on the number of variables and the number of

Experimental Design – Comparative Study

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1.Introduction:

In scientific studies, experimental design is the gold standard of research designs. This methodology relies on random assignment and laboratory controls to ensure the most valid, reliable results. Although researchers recognize that correlation does not mean causation, experimental designs produce the strongest, most valid results.

An experimental design consists of two groups of subjects: an experimental group and a control group. The experimental group undergoes the treatment, program or intervention of interest. Researchers then measure the differences between the two groups on a particular outcome,i.e., experimental design greatly reduces the chance of bias in the study

As example in transforming fabrics into garment it is necessary to know, besides the manner of processing, the behavior of the fabric in particular manufacturing processes. It is necessary to define why and how fabrics behave in a particular way when exposed to various strains. The answers to these questions are obtained by investigating fabric tailorability, as non-linear mechanical fabric properties at lower strains, which is the case in transforming fabrics into garments.

The area to be investigated is quite wide and the investigations presented here deal only with the most important elastic strains occurring in processing fabrics into garments, such as tensile, pressure, shear and bending, as each individual type of strain bears specific importance in studying fabric formability-sawability-sewabillity-formability, as well as in garment quality control. Strains impacting the fabric, i.e. the reaction of the fabric to these strains, are presented through the parameters of tailor ability properties. A relation is also explained between characteristic hysteresis curves and fabric behavior in real garment manufacturing processes, obtained through recording fabric behavior in particular garment manufacturing processes.

Results obtained through the investigations of tailor ability properties of the fabrics analyzed and their behavior in garment manufacturing processes helped to determine the so-called critical, or border values for particular parameters of tailor ability properties.